

**UNITED STATES PATENT AND TRADEMARK OFFICE**

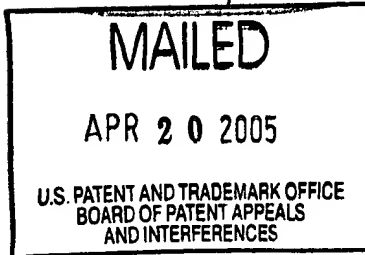
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**BEFORE THE BOARD OF PATENT APPEALS  
AND INTERFERENCES**

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*Ex parte* HEUNG-YEUNG SHUM, ZHENGYOU ZHANG, and QIFA KE

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Appeal No. 2004-2251  
Application No. 09/338,176

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HEARD: April 5, 2005

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Before MARTIN, JERRY SMITH, and BARRY, *Administrative Patent Judges*.  
BARRY, *Administrative Patent Judge*.

**DECISION ON APPEAL**

A patent examiner rejected claims 1-37. The appellants appeal therefrom under 35 U.S.C. § 134(a). We reverse.

**BACKGROUND**

The invention at issue on appeal is aimed at reconstructing a three-dimensional ("3D") scene from a sequence of two-dimensional ("2D") images. (Spec. at 1.<sup>1</sup>) Structure-from-motion ("SFM") algorithms have been used to reconstruct such

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<sup>1</sup>The appellants should number the lines of their specifications to facilitate specific citation thereto.

scenes. Aspects of SFM algorithms include "feature points," "baselines," and bundle adjustment. (*Id.* at 2.) A feature point is a point in an image that can be tracked well from one frame to another. Typically, corners of an object are considered good feature points. "The base line is associated with how a camera is moving in relation to an object depicted in an image." (*Id.*) "Bundle adjustment is a non-linear minimization process . . . typically applied to all of the input frames and features of the input image stream. Essentially, bundle adjustment is a non-linear averaging of the features over the input frames to obtain the most accurate 3D structure and camera motion." (*Id.*)

According to the appellants, "[t]here are . . . problems [associated] with conventional 3D reconstruction using SFM. For example, bundle adjustment of long sequence[s] of input frames may be computationally expensive if it involves processing the entire sequence of input frames and features at once." (Appeal Br. at 4.) Because "[t]he complexity of interleaving bundle adjustment for each iteration step may be measured as a function of the number of feature points and the number of frames being bundled," (*id.* at 5), they add, "bundle adjustment computed over a long sequence of input frames is time consuming and slows the entire 3D reconstruction." (*Id.*)

To overcome the shortcomings of conventional 3D reconstruction, the appellants' invention divides a long sequence of frames or images into smaller segments. "A 3D reconstruction is performed on each segment individually." (Spec. at 3.) "All the reconstructed segments are then combined . . . through an efficient bundle adjustment to complete the 3D reconstruction." (*Id.* at 29.) Because the complexity and, hence, the computational cost of 3D reconstruction and bundling are directly related to the number of frames being processed, the appellants assert that segmenting a longer sequence of frames reduces these costs. (Appeal Br. at 5.)

A further understanding of the invention can be achieved by reading the following claims.

1. A method of recovering a three-dimensional scene from two-dimensional images, the method comprising:

providing a sequence of images;

dividing the sequence of images into segments;

performing three-dimensional reconstruction for each segment individually; and

combining the three-dimensional reconstructed segments together to recover a three-dimensional scene for the sequence of images.

9. A method of recovering a three-dimensional scene from two-dimensional images, the method comprising:

identifying a sequence of two-dimensional frames that include two-dimensional images;

dividing the sequence of frames into segments, wherein a segment includes a plurality of frames;

for each segment, encoding the frames in the segment into at least two virtual frames that include a three-dimensional structure for the segment and an uncertainty associated with the segment.

Claims 1-37 stand rejected under 35 U.S.C. § 102(e) as anticipated by U.S. Patent No. 6,046,745 ("Moriya").

#### OPINION

Rather than reiterate the positions of the examiner or the appellants *in toto*, we focus on the main point of contention therebetween. Observing that "Moriya's column 32, lines 40-46 disclose that it is possible to apply the Moriya's invention to any previously taken image or footage," (Examiner's Answer at 5), the examiner asserts, "the discussion of footage discloses the sequence of images that are obtained from the segment of a motion picture film that depicts a particular event since it would take a multitude or sequence of images to capture the whole essence, scene of a particular event." (*Id.*) The appellants argue, "*Moriya* refers to the term 'footage' only once in the entire patent and uses that term unmistakably in the context of the term's meaning as 'a single image' not 'a sequence of images' as claimed." (Reply Br. at 5.)

In addressing the point of contention, the Board conducts a two-step analysis. First, we construe claims at issue to determine their scope. Second, we determine whether the construed claims are anticipated.

### 1. CLAIM CONSTRUCTION

"Analysis begins with a key legal question — *what* is the invention *claimed*?" *Panduit Corp. v. Dennison Mfg. Co.*, 810 F.2d 1561, 1567, 1 USPQ2d 1593, 1597 (Fed. Cir. 1987). Here, independent claim 1 recites in pertinent part the following limitations: "[a] method of recovering a three-dimensional scene from two-dimensional images, the method comprising: providing a sequence of images. . . ." Independent claims 9, 23, 31, 36, and 37 recite similar limitations. Considering these limitations, the independent claims require recovering a 3D scene from a sequence of 2D images.

### 2. ANTICIPATION DETERMINATION

"Having construed the claim limitations at issue, we now compare the claims to the prior art to determine if the prior art anticipates those claims." *In re Cruciferous Sprout Litig.*, 301 F.3d 1343, 1349, 64 USPQ2d 1202, 1206 (Fed. Cir. 2002). "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros., Inc. v. Union Oil Co.*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987) (citing

*Structural Rubber Prods. Co. v. Park Rubber Co.*, 749 F.2d 707, 715, 223 USPQ 1264, 1270 (Fed. Cir. 1984); *Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 1548, 220 USPQ 193, 198 (Fed. Cir. 1983); *Kalman v. Kimberly-Clark Corp.*, 713 F.2d 760, 771, 218 USPQ 781, 789 (Fed. Cir. 1983)). "[A]bsence from the reference of any claimed element negates anticipation." *Kloster Speedsteel AB v. Crucible, Inc.*, 793 F.2d 1565, 1571, 230 USPQ 81, 84 (Fed. Cir. 1986).

Here, Moriya discloses "an image processing arrangement to determine camera parameters and make a three-dimensional shaped model of an object from a single frame picture image . . . in an interactive mode." Abs., ll. 1-4. Although the arrangement recovers a 3D scene, we are unpersuaded that it does so from a sequence of 2D images. To the contrary, the reference emphasizes that it operates on a single image. Specifically, "[i]t is important to note that within the present invention, determination of camera parameters, extraction of 3-D image data of objects and determination of 2-D CG image data are all **preferably and advantageously conducted using a single frame picture image (i.e., as opposed to having to use multiple differing frames** to determine camera parameters, etc.)." Col. 29, ll. 46-52 (emphasis added). Although the passage of Moriya cited by the examiner mentions "footage," it discloses that a single image can be drawn from such footage.

Specifically, "since the camera parameters can be determined directly from a **single image**, it is not necessary to set or record the camera parameters when **an image** is actually taken with a camera, and further, it is also possible to apply CG modelling to any previously taken **image** (e.g., vintage or historical footage) of which camera parameters are not known." Col. 32, ll. 40-46 (emphases added).

The absence of recovering a 3D scene from a sequence of 2D images negates anticipation. Therefore, we reverse the anticipation rejection of claim 1; of claims 2-8, which depend therefrom; of claim 9; of claims 10-22, which depend therefrom; of claim 23; of claims 24-30, which depend therefrom; of claim 31; of claims 32-35, which depend therefrom; and of claims 36 and 37.

#### CONCLUSION

In summary, the rejection of claims 1-37 under § 102(e) is reversed.

*John C. Martin*  
JOHN C. MARTIN  
Administrative Patent Judge

*Jerry Smith*  
JERRY SMITH  
Administrative Patent Judge

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Page 9

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